University of Reading

Vertical wind profiles over Greater London

Daniel Drew
d.r.drew@reading.ac.uk

Introduction

To design tall buildings in urban areas, wind engineers need to calculate the potential wind loading on the structure.

This requires information on:

- Geometry of the structure
- Geometry and proximity of the structures upwind
- Characteristics of the approaching wind

Wind loading codes inform the calculation process- design wind loads

- 50-year return period hourly mean wind speed

Wind speed profiles in strong wind conditions

- Neutral stability

Wind speed profile models

- Power Law (Japan, Canada)

$$U(z) = U_{ref}\left(\frac{z}{z_{ref}}\right)^{\propto}$$

α =0.32 for an urban surface (Cook, 1985).

- Log law (Eurocode)

$$U(z) = \frac{u_*}{\kappa}\ln\left(\frac{z}{z_0}\right)$$

z_0=0.8 m for an urban surface (Cook, 1985).

- Deaves and Harris Model (UK, Australia)

$$U(z) = \frac{u_*}{k}\left[ln\left(\frac{z}{z_0}\right) + 5.75\left(\frac{z}{h}\right) - 1.88\left(\frac{z}{h}\right)^2 - 1.33\left(\frac{z}{h}\right)^3 + 0.25\left(\frac{z}{h}\right)^4\right]$$

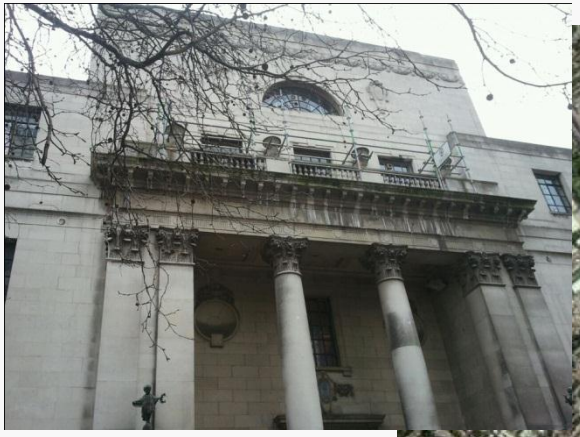
h, the height of the boundary layer is assumed to equal 3250 m.

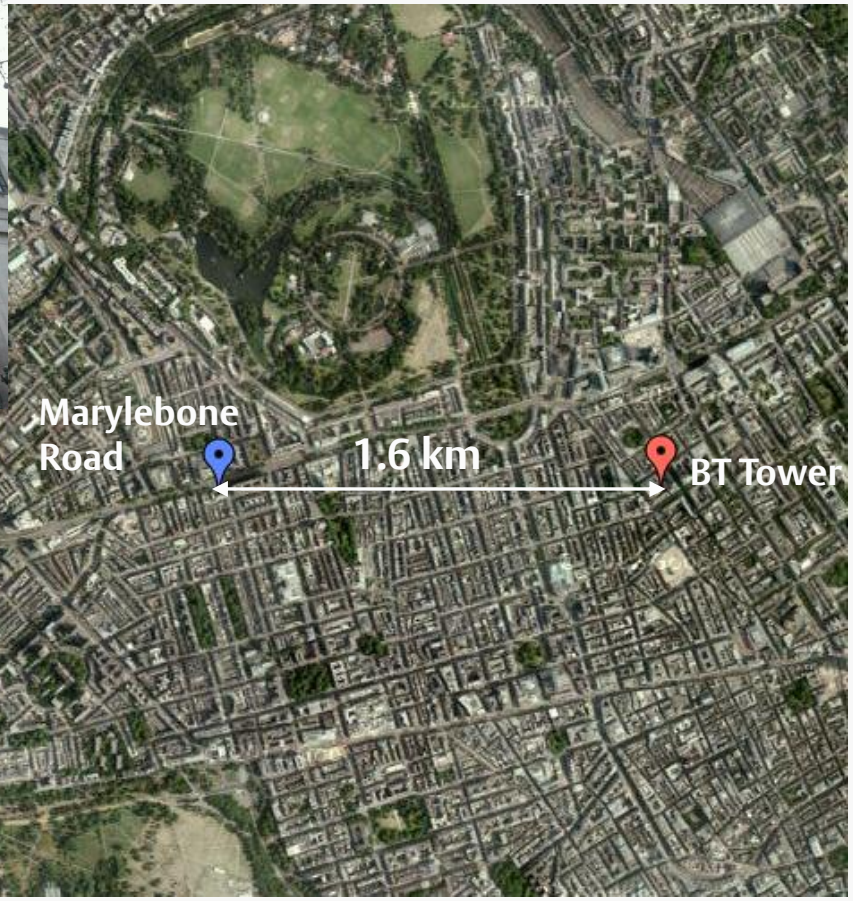
ACTUAL ADVANCED CLIMATE TECHNOLOGY: URBAN ATMOSPHERIC LABORATORY

University of Reading

ACTUAL ADVANCED CLIMATE TECHNOLOGY: URBAN ATMOSPHERIC LABORATORY

University of Reading

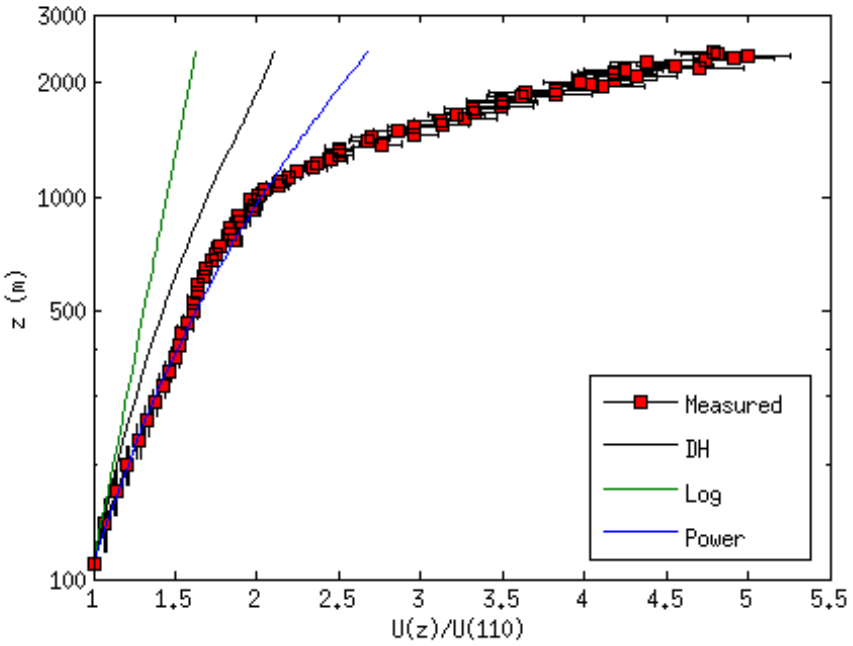


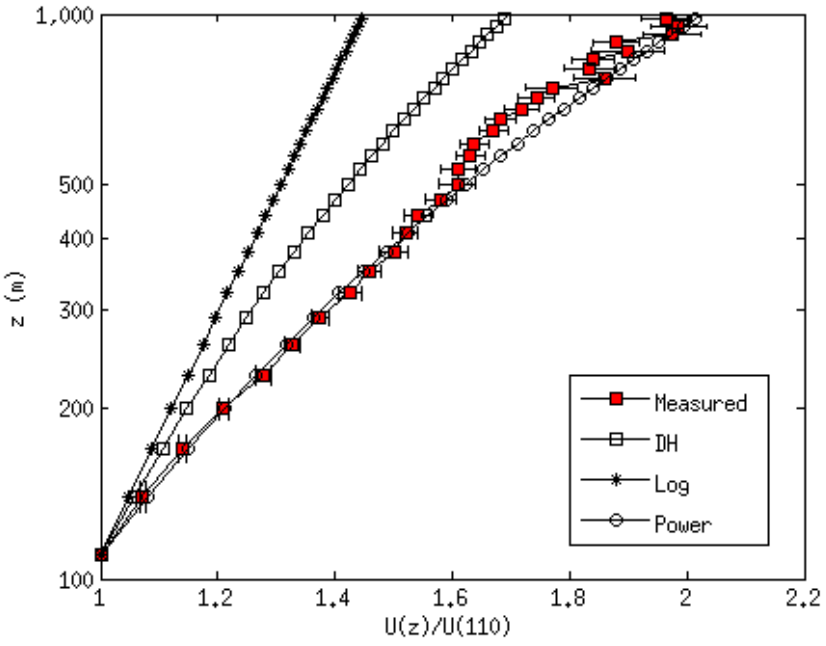


Lidar

- User configurable scan pattern.
- Doppler Beam Swinging (DBS): a 3-beam wind-profiling method (Lane and Barlow).
- 30 m vertical resolution (80 gates).
- First 3 gates are unusable (lowest observation at 110 m agl).
- 2 minutes between each scan.
- 21st May 2011 – 6th Jan 2012.

Mean wind speed profile





Wind speed profiles in strong winds

Profile data filtered by the wind speed measured in lowest gate, U(110).

LOW:

$U<U_{Q25}$

MEDIUM:

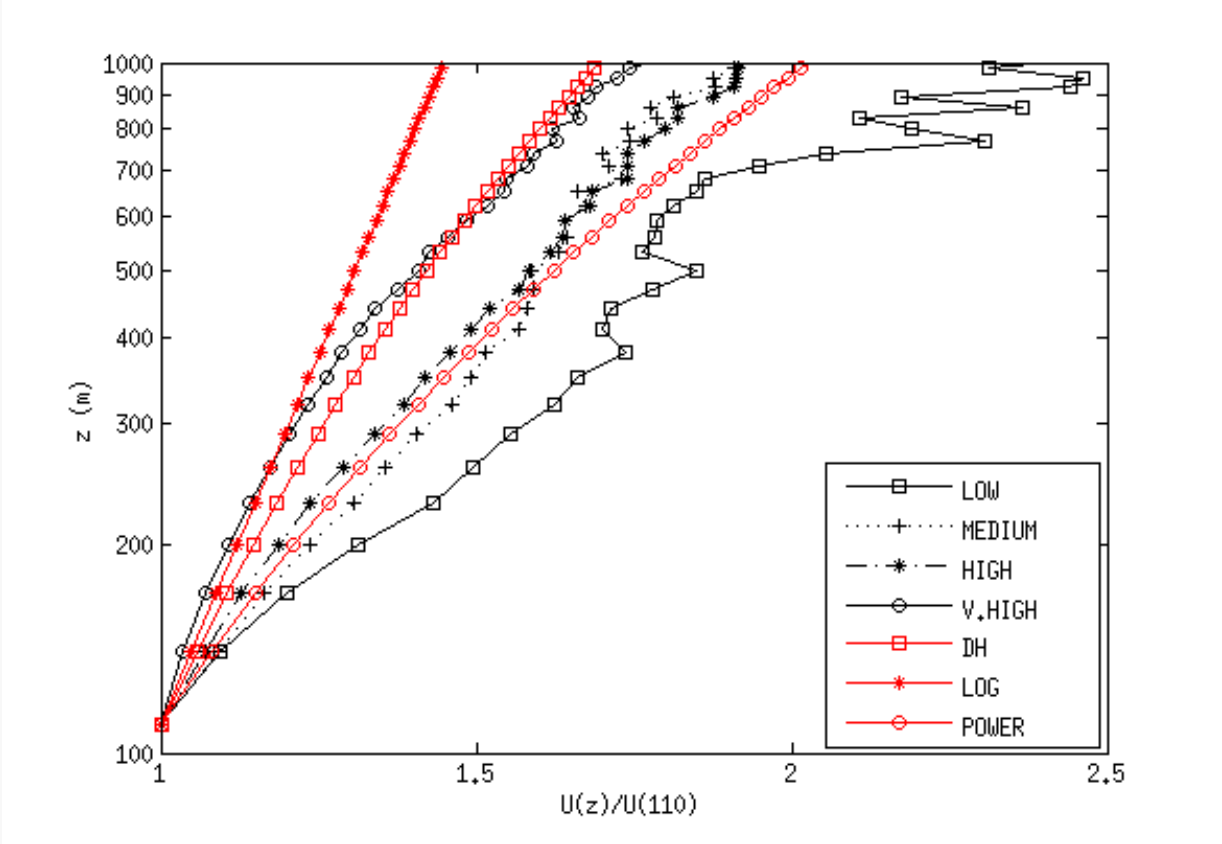
$U_{Q25}<U<U_{Q50}$

HIGH:

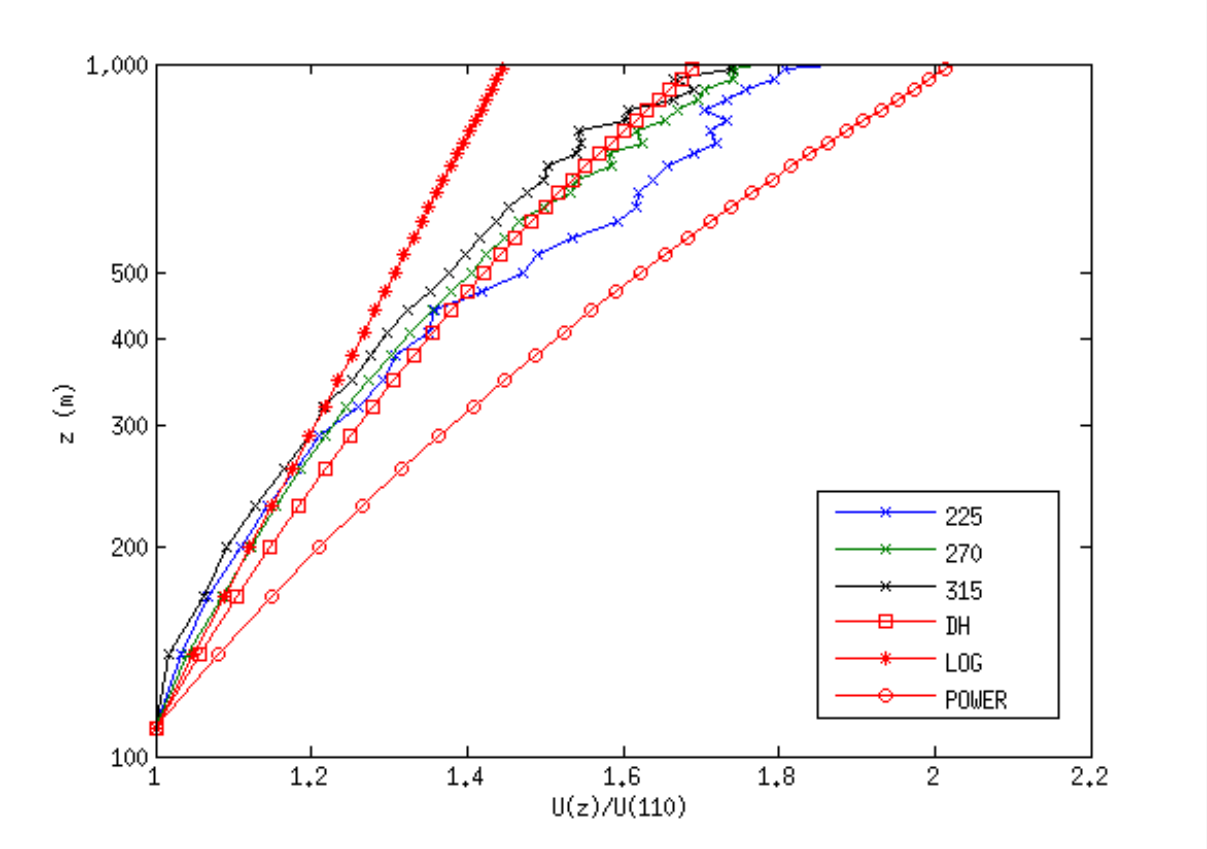
$U_{Q50}<U<U_{Q75}$

VERY HIGH:

$U>U_{Q75}$



Mean wind speed profiles



Terrain-dependent parameters

Observations from BT Tower analysed to estimate U_*

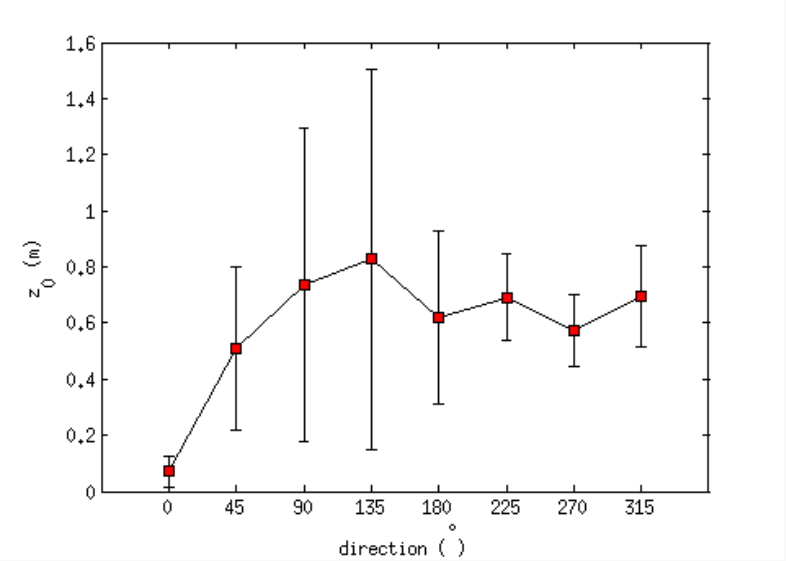
$$U_*{}^2 = \sqrt{\overline{u'w'}^2 + \overline{v'w'}^2}$$

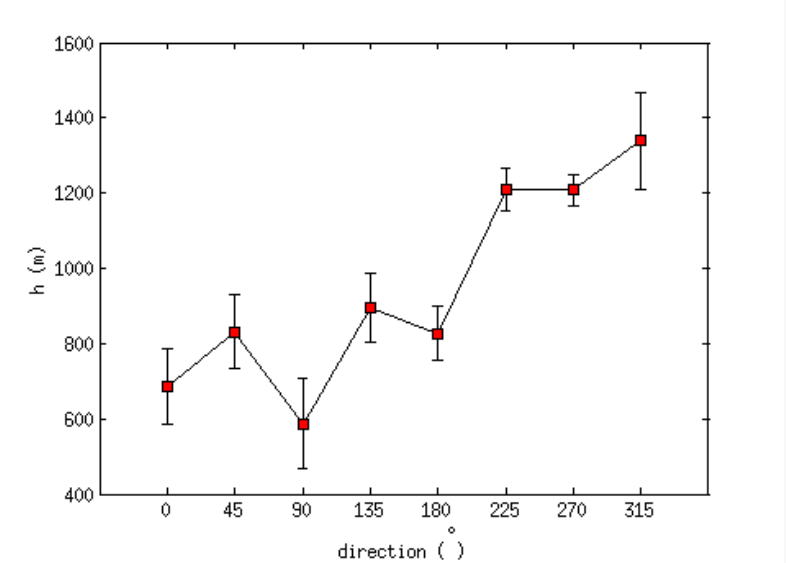
$$\alpha = \frac{1}{\ln\left[\frac{(z_1 z_2)^{0.5}}{z_0}\right]}$$

z_0 and α values lower than those given in UK code (z_0=0.8 m, α=0.32).

$$h = \frac{U_*}{6f}$$

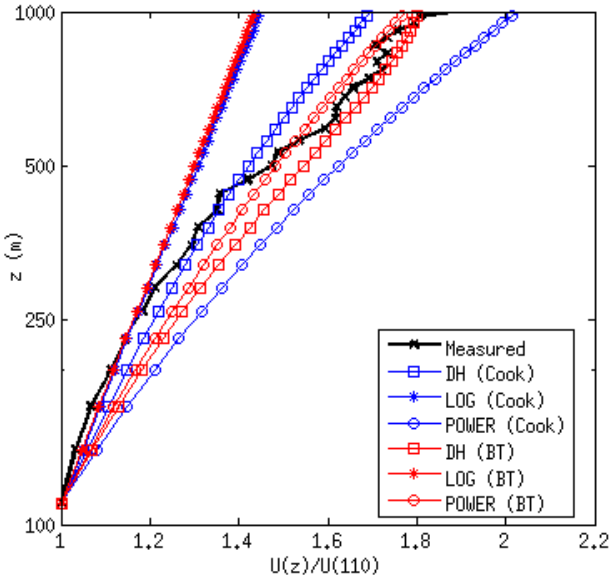
Boundary layer height lower than 3250 m.



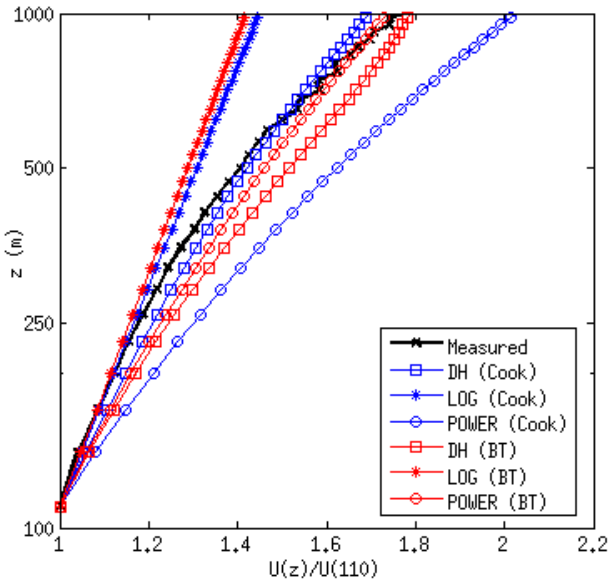


Results

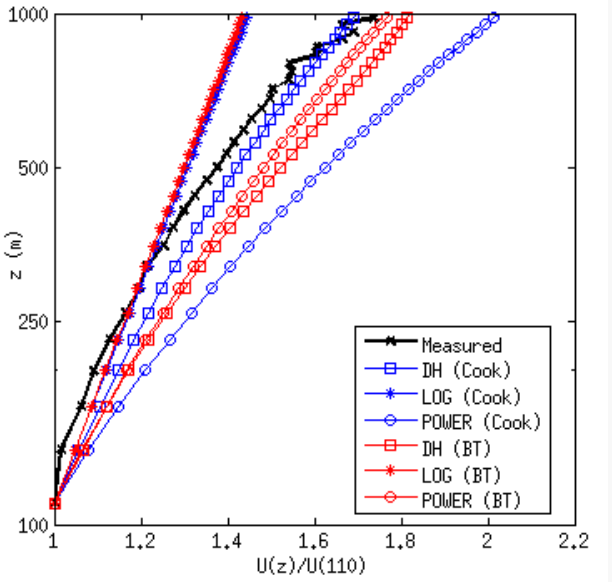
225°



270°



315°



University of Reading

Conclusions

- Presented wind speed profiles derived from lidar observations.
- Deaves and Harris model, using parameters given in code provides a good representation of the wind speed profile in strong wind conditions over Greater London.
- Scope for improving models by using a detailed assessment of surface parameters.
- Limitations of Doppler lidar in urban areas restricts potential to assess wind loading models- potential for Sodar.